PCT
D INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : H04Q 7/38 | A1

(11) International Publication Number: WO 97/36447

(43) International Publication Date: 2 October 1997 (02.10.97)

(21) International Application Number: PCT/IE97/00027

(22) International Filing Date: 27 March 1997 (27.03.97)

(30) Priority Data:
S960255 28 March 1996 (28.03.96) IE

(71) Applicant *(for all designated States except US)*: MARKPORT LIMITED [IE/IE]; First floor, Marine House, Clanwilliam Court, Dublin 2 (IE).

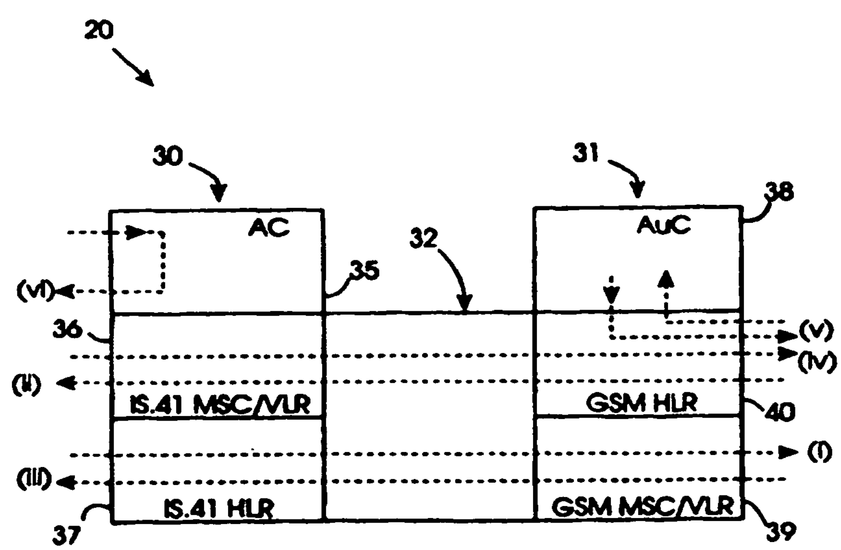
(72) Inventors; and
(75) Inventors/Applicants *(for US only)*: CUNNINGHAM, Joseph [IE/IE]; Apartment 4, 16 Duke Street, Dublin 2 (IE). COLLINS, Augustine [IE/IE]; 4 Cloister Avenue, Carysfort Avenue, Blackrock, County Dublin (IE). O'SHEA, Neillus [IE/IE]; 35 Applewood Heights, Greystones, County Wicklow (IE). DILLON, Aidan [IE/IE]; 15 Cloister Way, Carysfort Avenue, Blackrock, County Dublin (IE).

(74) Agents: O'CONNOR, Donal, H. et al.; Cruickshank & Co., 1 Holles Street, Dublin 2 (IE).

(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DE (Utility model), DK, DK (Utility model), EE, ES, FI, GB, GE, HU, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, TJ, TM, TR, TT, UA, UG, US, UZ, VN, ARIPO patent (GH, KE, LS, MW, SD, SZ, UG), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).

Published
With international search report.
Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

(54) Title: A ROAMING INTERWORKING GATEWAY FOR MOBILE TELECOMMUNICATIONS SYSTEMS



(57) Abstract

A roaming interworking gateway (RIG, 20) has a modular unit (30) associated with an IS.41 system, a modular unit (31) associated with a GSM system, and a translation function (32). The translation function (32) accesses a database which stores subscriber data upon registration of a subscriber in a roamed mobile system. Each modular unit (30, 31) comprises an authentication centre to perform authentication before registration. The RIG (20) is implemented on a distributed hardware structure having a high-speed network (51) to which are connected network access processors (NAP, 64), database servers (62), and an operations and maintenance processor (63). Each modular unit resides on a single network access processor. The translation function has a module residing on the NAP of each associated modular unit.

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania
AM	Armenia
AT	Austria
AU	Australia
AZ	Azerbaijan
BA	Bosnia and Herzegovina
BB	Barbados
BE	Belgium
BF	Burkina Faso
BG	Bulgaria
BJ	Benin
BR	Brazil
BY	Belarus
CA	Canada
CF	Central African Republic
CG	Congo
CH	Switzerland
CI	Côte d'Ivoire
CM	Cameroon
CN	China
CU	Cuba
CZ	Czech Republic
DE	Germany
DK	Denmark
EE	Estonia
ES	Spain
FI	Finland
FR	France
GA	Gabon
GB	United Kingdom
GE	Georgia
GH	Ghana
GN	Guinea
GR	Greece
HU	Hungary
IE	Ireland
IL	Israel
IS	Iceland
IT	Italy
JP	Japan
KE	Kenya
KG	Kyrgyzstan
KP	Democratic People's Republic of Korea
KR	Republic of Korea
KZ	Kazakstan
LC	Saint Lucia
LI	Liechtenstein
LK	Sri Lanka
LR	Liberia
LS	Lesotho
LT	Lithuania
LU	Luxembourg
LV	Latvia
MC	Monaco
MD	Republic of Moldova
MG	Madagascar
MK	The former Yugoslav Republic of Macedonia
ML	Mali
MN	Mongolia
MR	Mauritania
MW	Malawi
MX	Mexico
NE	Niger
NL	Netherlands
NO	Norway
NZ	New Zealand
PL	Poland
PT	Portugal
RO	Romania
RU	Russian Federation
SD	Sudan
SE	Sweden
SG	Singapore
SI	Slovenia
SK	Slovakia
SN	Senegal
SZ	Swaziland
TD	Chad
TG	Togo
TJ	Tajikistan
TM	Turkmenistan
TR	Turkey
TT	Trinidad and Tobago
UA	Ukraine
UG	Uganda
US	United States of America
UZ	Uzbekistan
VN	Viet Nam
YU	Yugoslavia
ZW	Zimbabwe

"A roaming interworking gateway for mobile telecommunications systems"

The invention relates to a roaming interworking gateway (RIG) for interworking of two non-compatible mobile telecommunications systems such as those based on the GSM, IS.41, and PDC standards. Such systems are often alternatively referred to as networks.

Several such gateways are known and are described, for example, in WO 95\27382 (L.M. Ericsson), WO 95\01069 (Vodaphone), EP 379642 (GTE), WO 94\05129 (L.M. Ericsson), and WO 96\24226 (Qualcomm). It appears that these specifications are quite effective at allowing interworking of two non-compatible systems for which they are built. However, the demand for production of gateways for a wide variety of different non-compatible systems such as different systems working within the general IS.41 standard in the U.S.A., the European-based GSM, the Japanese PDC, and various other systems such as those in Asia, is difficult to meet because of the long lead times which are involved in development of the systems. This is because they are specifically programmed for the particular pair of non-compatible systems, and they are often integrated with switches in hardware. A related disadvantage is that they are difficult to modify and upgrade and it is also difficult to extend the interworking capabilities as interworking requirements grow.

It is therefore an object of the invention to provide a RIG which is easily scalable and is easily modified to adapt to changing circumstances. More particularly, it is also an object of the invention to provide a RIG which provides at least some of the following services:-

to allow subscribers of one system to roam transparently in another system and to receive and make calls using their home telephone number,

to support billing services for different types of roamers,

to preserve, where possible, supplementary services between the systems where that service can be provided, such as call forwarding, and

to provide additional services to roamers when visiting a system.

According to the invention, there is provided a roaming interworking gateway for interworking of at least two mobile telecommunication systems having non-compatible standards, the gateway comprising:

a modular unit associated with a first mobile system and comprising a pseudo network element of the first system;

a modular unit associated with a second mobile system and comprising a pseudo network element for the second system; and

an interworking translation function linking the modular units and comprising means for performing data and protocol conversion between the units.

Preferably, each modular unit comprises at least two pseudo network elements at different hierarchal mobile system levels.

In one embodiment, each modular unit comprises a pseudo HLR, and a pseudo MSC or VLR or both an MSC and a VLR.

Ideally, each pseudo HLR comprises means for routing signalling set-up signals for a terminating call to a visited system, the MSC or VLR comprising means for receiving such signals from a home system.

In another embodiment, each modular unit comprises an authentication function comprising means for authenticating roamers in the associated mobile system domain.

Preferably, each modular unit comprises a MAP-Interface which comprises means for accessing a database.

In one embodiment, the translation function comprises a translation module interacting with the MAP-User of each MAP-Interface and comprising means for accessing a database.

In a further embodiment, said database access means comprises means for directing storage of subscriber profile data when a subscriber roams in one of the associated mobile systems to provide profile translation in a transparent manner. Ideally, each modular unit resides on a network access processor.

Preferably, the translation function comprises at least two translation modules residing on one or more network access processors.

In another embodiment, the gateway comprises a high speed network linking hardware machines in a distributed manner.

Preferably, the gateway further comprises an operations and maintenance processor connected to the network.

Ideally, the gateway further comprises a billing conversion function.

In one embodiment, the billing conversion function resides on an operations and maintenance processor of the gateway.

The invention will be more clearly understood from the following description of some embodiments thereof, given by way of example only with reference to the accompanying drawings, in which,

Fig. 1 is a schematic representation showing the context of a gateway of the invention;

Fig. 2 is a schematic diagram illustrating connections for interworking between a GSM system and an IS.41 system;

Fig. 3 is a high-level diagram illustrating the modular structure of a gateway of the invention;

Fig. 4 is a diagram illustrating the major functional components of a gateway and the way in which signals are routed through it;

Figs. 5(a), 5(b) and 5(c) are diagrams illustrating implementations of gateways of the invention in hardware terms; and

Figs. 6 to 9 are signal transfer diagrams for operation of a gateway.

Referring to the drawings, and initially to Fig. 1 there are shown two roaming interworking gateways (RIGs) 1 and 10 of the invention. The RIG 1 is connected to a relatively small GSM system 2 having a combined home location register (HLR) and mobile switching centre (MSC). The RIG 1 allows interworking of the system 2 via a ground station (not shown) and a satellite system 3 with various IS.41 systems 5. The RIG 10 allows interworking of a relatively large GSM system 11 with the IS.41 systems 5 via an SS7 signalling system 12.

Referring now to Fig. 2, examples of interworking signals are shown in a general arrangement. The signals are interworked by a RIG 20 between an IS.41 system 21 and a GSM system 22. The interrupted lines 23 illustrate a set-up signal for a terminating call in which a GSM user roaming in the IS.41 system 21 is called. The signal is routed up through the layers of the GSM system 22, namely the mobile unit (MU), the base transceiver station (BTS), the base switching centre (BSC), the mobile switching centre (MSC), the signalling system (SS7) and the HLR. The HLR recognises that the called subscriber is roaming in the IS.41 system 21 and routes the signal to the RIG 20, which in turn routes it to the MSC of the IS.41 system 21 via the SS7. The signal then passes down through the BSC and BTS layers of the IS.41 system 21 until it reaches the called subscriber MU. This establishes the connection, and from then on the actual call takes place between the MSCs of the two systems, as illustrated by the full signal lines 24. If the call originated from a telephone of a fixed PSTN system, then it would be routed directly into the GSM signalling system SS7. Other types of signals such as location update or registration, authentication, or supplementary service signals can also be transmitted. These are described in more detail below.

Referring now to Figs. 3 and 4, the functional structure of the RIG 20 of the invention is illustrated. A very important aspect of the RIG is that it has the following features:-

Network resilience. This ensures that there is no loss of service in the event of failure of a hardware or software component.

Scalable capacity. For example, it is possible to scale a RIG of the invention from a capacity of 1 million subscribers up to 4 million subscribers.

On-line upgrade capability. It is important to have the ability to easily add capacity and features without service disruption.

Numbering flexibility. The RIG ensures total flexibility in allocation of subscriber numbers such as IMSIs and MINs.

Flexibility. The RIG has the ability to define, trial and deploy new features and services in a simple manner.

Features of the RIG which achieve the above include the fact that the functionality is provided in software modules and that the physical implementation is in a distributed network arrangement.

Referring to Fig.3, modularity at its highest level is illustrated, in which the RIG 20 comprises an IS.41 modular unit 30, a GSM modular unit 31, and a translation function 32. Each of the parts 30, 31 and 32 may be easily upgraded or modified independently of the other parts. Further, the RIG may be expanded to cater for

additional interworking by simply adding modular units and translation functions associated with additional telecommunication systems to be interworked.

Referring now to Fig. 4 the structure of each of the modular units is now described in more detail. The modular unit 30 comprises an authentication centre (AC) 35, a pseudo IS.41 MSC\VLR 36 and a pseudo IS.41 HLR 37. The modular unit 31 comprises a GSM HLR 40, a pseudo GSM MSC\VLR 39, and a GSM authentication centre (AuC) 38. These are the basic functional components of the modular units. As is clear from Fig. 2 in conjunction with Fig. 4, when the RIG 20 is connected to two systems such as the systems 21 and 22 shown in Fig 2 the GSM side wall interface with pseudo GSM network elements, namely the HLR 40 and the MSC\VLR 39. Thus, the GSM system 22 "thinks" it is communicating with another GSM system. The same comments apply to the IS.41 side whereby the IS.41 system 21 communicates with the IS.41 modular unit 30. The cross-standard nature of the communication is transparent to the systems 21 and 22 because the pseudo network elements of the RIG 20 interact as if they were real elements of a compatible system. Fig. 4 also shows various signals (i) to (vi) which are described in more detail below.

Referring now to Figs. 5(a) and 5(b) physical implementations of the RIG 20 are illustrated. The architecture is distributed in which there are three types of components configured in a redundant fashion. The three layers of components are:

Network access processors. These provide access to the RIG. Each network access processor (NAP) is a stand-alone component which can be located remotely from all other NAPs and other components of the RIG.

Nodes accessing the RIG have a first choice and second choice route to differing NAPs for high availability. The NAPs are deployed in an "N+1 redundant" configuration thus providing the joint benefits of being able to add capacity through deployment of additional systems and also no loss of service on system failure.

Database Servers. These provide a fully centralised, redundant subscriber database for the RIG. These can be enhanced to act as service data points (SDPs) with other intelligent network components. The database servers are deployed in a "2N redundant" configuration, thus ensuring that all subscriber data is maintained in at least two locations and there is no loss of service on failure of a database server.

Operations and maintenance processor. This provides full administration and management of the RIG, including mediation with the operators subscriber administration and network management systems.

As shown in Fig. 5 (a), the RIG 50 has a high speed network 51 to which is connected an OMP machine 52 and a pair of DBS\NAP machines 53. A RIG 60 shown in Fig 5(b) has a larger capacity and comprises a high speed network 61, four DBS machines 62, one OMP machine 63, and four NAP machines 64.

The link between the functional architecture of Figs. 3 and 4 and the physical architectures of Figs. 5(a) and 5(b) is now described with reference to Fig. 5(c). Each NAP 64 comprises the following software modules to form a modular unit:-

- a MAP-Interface having an SS7 stack 70, a MAP-Provider 71, and a MAP-User 72,

- database access and other interfaces 73,

- an authentication module AC 35 or AuC 38, as appropriate.

As is clear from the diagram of Fig. 5(c), the MAP-User 72 has access to the database servers 62. Each NAP 64 is associated with one modular unit.

The translation function 32 is shown by interrupted lines. It comprises translation modules 80 and 81 residing on the same NAPs as the modular units 30 and 31 respectively. These modules have access to databases residing on the database servers 62, as illustrated.

Alternative configurations could be used instead. For example, two modular units may reside on a single NAP 64, operating functionally as if they were on separate machines. Also, the AC and AuC could be on separate machines connected to the high speed network.

Referring now to Figs. 6 to 9, the manner in which signals are handled by a RIG of the invention is illustrated. To take the example of a GSM subscriber roaming in an IS.41 system, the following sets out the signals which are handled. To set up the RIG, the MIN, ESN, IMSI, authorisation period, and authorisation value data items are inputted to the RIG via the OMP machine 63. Referring in particular to Fig 6, the signalling transfer when the GSM roamer initially registers in the IS.41 domain is illustrated. The RIG determines that the subscriber has first roamed as the location data is empty. Upon operating his or her mobile unit in the IS.41 domain, the

IS.41 VLR transmits a registration notification signal 100 (REGNOT) to the RIG. The RIG then stores the subscriber location data, and transmits a signal 101 to the GSM HLR indicating the location update. The GSM HLR then transmits a signal 102 containing the subscriber profile data. The RIG then stores this data and acknowledges receipt with a signal 103. The GSM HLR then indicates with a signal 104 that it has terminated the signalling. The RIG then indicates with a signal 105 to the IS.41 VLR that the profile has been updated. This data is stored by the RIG in the database associated with the translation function 32 shown in Fig. 4. This data is very important as it allows transfer of important data to provide supplementary services such as call forwarding in a transparent manner.

Referring in particular to Fig. 7, the signalling sequence when the GSM subscriber continues to roam in the IS.41 system is illustrated. Because the RIG has already stored the subscriber profile there is no need for any signalling in the GSM system. The RIG downloads the stored subscriber profile to the new serving VLR with a signal 111 in response to a notification 110. A registration cancellation signal 112 is then transmitted to the old serving IS.41 VLR, this being acknowledged by a signal 113.

Referring now to Fig. 8, the signalling sequence for return of the GSM subscriber to the GSM network is illustrated. The RIG receives a cancellation signal 120 and acknowledges it with a signal 121. To perform the cancel function, the RIG removes all transient data for the subscriber and sends an IS.41 registration cancellation signal 122 to the last IS.41 VLR in which the subscriber was roaming. This is acknowledged by a signal 123.

Referring now to Fig. 9, the signalling diagram for a successful mobile terminating call to a GSM subscriber roaming in a IS.41 territory is shown. The RIG inserts its own location data as the IS.41 originating MSC. This is used later when the RIG performs the function of a dummy IS.41 MSC for forwarding the call. All mobile terminating calls for the roaming GSM subscriber are routed to the RIG via the GSM HLR. For this reason, restrictions to mobile terminating calls will be implemented by the subscriber's GSM HLR and need not be duplicated in the RIG. The GSM HLR provides the roaming number with a signal 130 and the RIG transmits a route request signal 131 to the serving IS.41 VLR. The serving IS.41 VLR 132 returns a TLDN signal 132 to the RIG. If this is in a national format, a table mapping country codes to VLRs is necessary. A look-up is then performed to this table to find the country code of the VLR. This is then added to the TLDN to form the international E.164 MSRN returned to the GSM HLR in a signal 133.

The signals 130 and 133 correspond to the part of the signal 23 of Fig. 2 on the right side of the RIG 20, and the signals 131 and 132 to that part of the signal 23 on the left side of the RIG 20.

The manner in which signals are routed through the RIG is shown in more detail in Fig. 4 as a set of signals (i) to (vi). The signal (i) is transmitted through the RIG for registration of a GSM subscriber roaming in the IS.41 system, and the signal (ii) for registration of an IS.41 subscriber roaming in the GSM system. The signal (iii) is transmitted for setting up a call to a GSM roamer in the IS.41 system. As is clear from Fig. 4, this signal is routed through the pseudo GSM MSC/VLR, the translation function 32, and the pseudo IS.41 HLR and then onto the

IS.41 signalling system. The opposite happens for a call to an IS.41 subscriber roaming in the GSM system and this is indicated by the signal (iv).

As is clear from this diagram, the interworking signals pass through the translation function. This involves translation operations such as:-

- Data conversion, e.g. changing an IS.41 MIN to a GSM IMSI,

- Code or protocol conversion, including all signalling formats. An example is conversion of a GSM Provide Roaming Number request to an IS.41 Route Request.

Also shown in this diagram are the handling of signals for authentication. For example, the signal (v) is routed through the AuC 38 and the GSM HLR 40 for an authentication request by an IS.41 subscriber roaming in the GSM system. The signal (vi) is transmitted through the AC 35 when an IS.41 VLR is authorising a GSM subscriber roaming in its territory. As is clear from the diagram, the AuC 38 interacts with the GSM HLR 40 for authentication.

Another function of the translation function 32 is billing conversion. A billing conversion component is a modular software module which forms the necessary protocol conversion between billing centres in the different non-compatible mobile systems. The billing converter performs error checking on billing files and billing records and raises an alarm if any error is found. The billing convertor is configured to continue processing remaining billing records in the file, or to discard the complete file. Another function is conversion of telephone numbers

such as MIN to IMSI. This function is implemented as a software module on the OMP machine.

It will be appreciated that the invention provides a simple and modular construction of RIG. This allows easy upgrading, maintenance and modification. For example, a RIG may be easily upgraded for interworking with a third system by simply adding a second translation function and a third modular unit associated with the third system. Additional supplementary services are easily added by connection of modules on top of the MAP-Interface of the relevant modular unit. An example of the flexibility which is allowed is that if a subscriber in a GSM domain only wants to register as a roamer in an IS.41 domain, this can be achieved by registration only in the IS.41 HLR 37 of the modular unit 30. In this case, registration signals when the subscriber is roaming in the IS.41 domain terminate at the IS.41 HLR 37, which is effectively the real HLR for the subscriber. This situation may arise for example if a European subscriber only wants to use a digital cellular unit when visiting the USA - either using no cellular unit or an analog unit at home.

The fact that the RIG comprises pseudo network elements means that it can be very easily installed using conventional initialisation for real network elements such as HLRs, MSCs etc. Also, production of a RIG has a considerably reduced design lead time because its design is based on components such as a MAP-Interface which are standard for systems.

The invention is not limited to the embodiments hereinbefore described, but may be varied within the scope of the claims in construction and detail.

CLAIMS

1. A roaming interworking gateway for interworking of at least two mobile telecommunication systems having non-compatible standards, the gateway comprising:

a modular unit associated with a first mobile system and comprising a pseudo network element of the first system;

a modular unit associated with a second mobile system and comprising a pseudo network element for the second system; and

an interworking translation function linking the modular units and comprising means for performing data and protocol conversion between the units.

2. A gateway as claimed in claim 1, wherein each modular unit comprises at least two pseudo network elements at different hierarchal mobile system levels.

3. A gateway as claimed in claim 2, wherein each modular unit comprises a pseudo HLR, and a pseudo MSC or VLR or both an MSC and a VLR.

4. A gateway as claimed in claim 3, wherein each pseudo HLR comprises means for routing signalling set-up signals for a terminating call to a visited system, the MSC or VLR comprising means for receiving such signals from a home system.

5. A gateway as claimed in any preceding claim, wherein each modular unit comprises an authentication

function comprising means for authenticating roamers in the associated mobile system domain.

6. A gateway as claimed in any preceding claim, wherein each modular unit comprises a MAP-Interface which comprises means for accessing a database.

7. A gateway as claimed in claim 6, wherein the translation function comprises a translation module interacting with the MAP-User of each MAP-Interface and comprising means for accessing a database.

8. A gateway as claimed in claim 7, wherein said database access means comprises means for directing storage of subscriber profile data when a subscriber roams in one of the associated mobile systems to provide profile translation in a transparent manner.

9. A gateway as claimed in any of claims 6 to 8, wherein each modular unit resides on a network access processor.

10. A gateway as claimed in claim 9, wherein the translation function comprises at least two translation modules residing on one or more network access processors.

11. A gateway as claimed in claim 9 or 10, wherein the gateway comprises a high speed network linking hardware machines in a distributed manner.

12. A gateway as claimed in claim 11, further comprising an operations and maintenance processor connected to the network.

13. A gateway as claimed in any preceding claim, further comprising a billing conversion function.

14. A gateway as claimed in claim 13, wherein the billing conversion function resides on an operations and maintenance processor of the gateway.

15. A gateway substantially as described with reference to and as illustrated in the accompanying drawings.

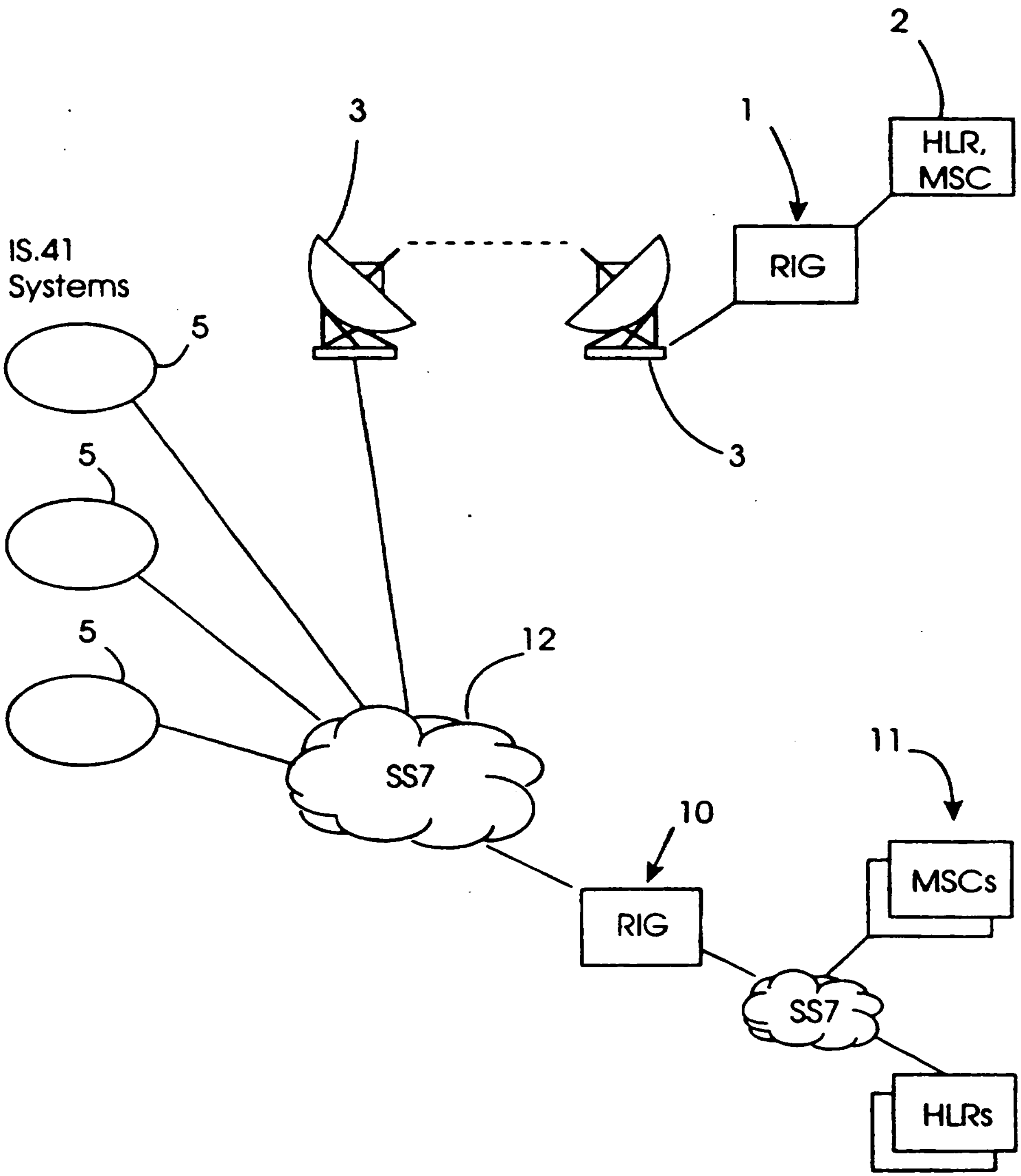

2
3
1
HLR, MSC
RIG
IS.41 Systems
5
5
5
3
12
SS7
11
10
MSCs
RIG
SS7
HLRs

Fig. 1

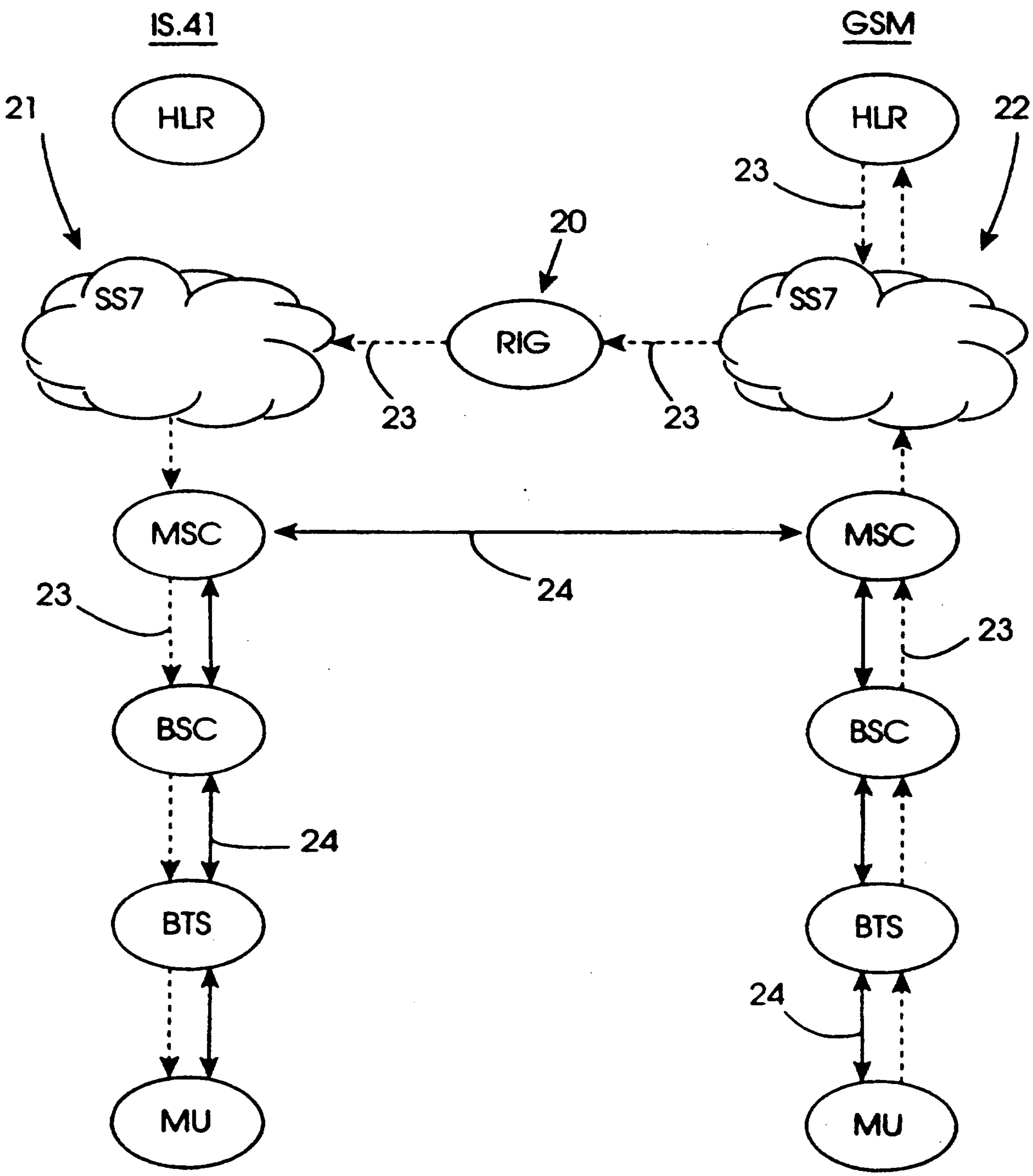

IS.41
GSM
HLR
HLR
21
22
23
20
SS7
RIG
SS7
23
23
MSC
MSC
24
23
23
BSC
BSC
24
BTS
BTS
24
MU
MU

Fig. 2

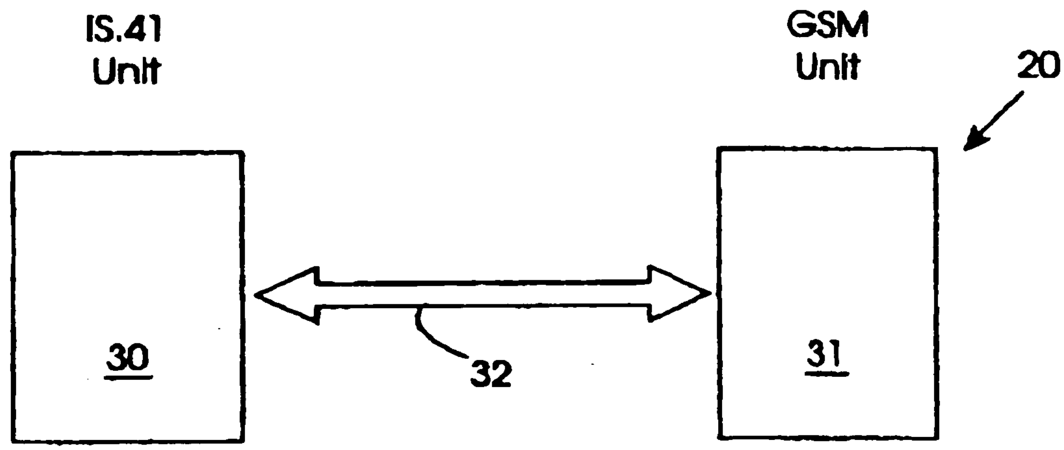

IS.41
Unit
GSM
Unit
20
30
32
31

Fig. 3

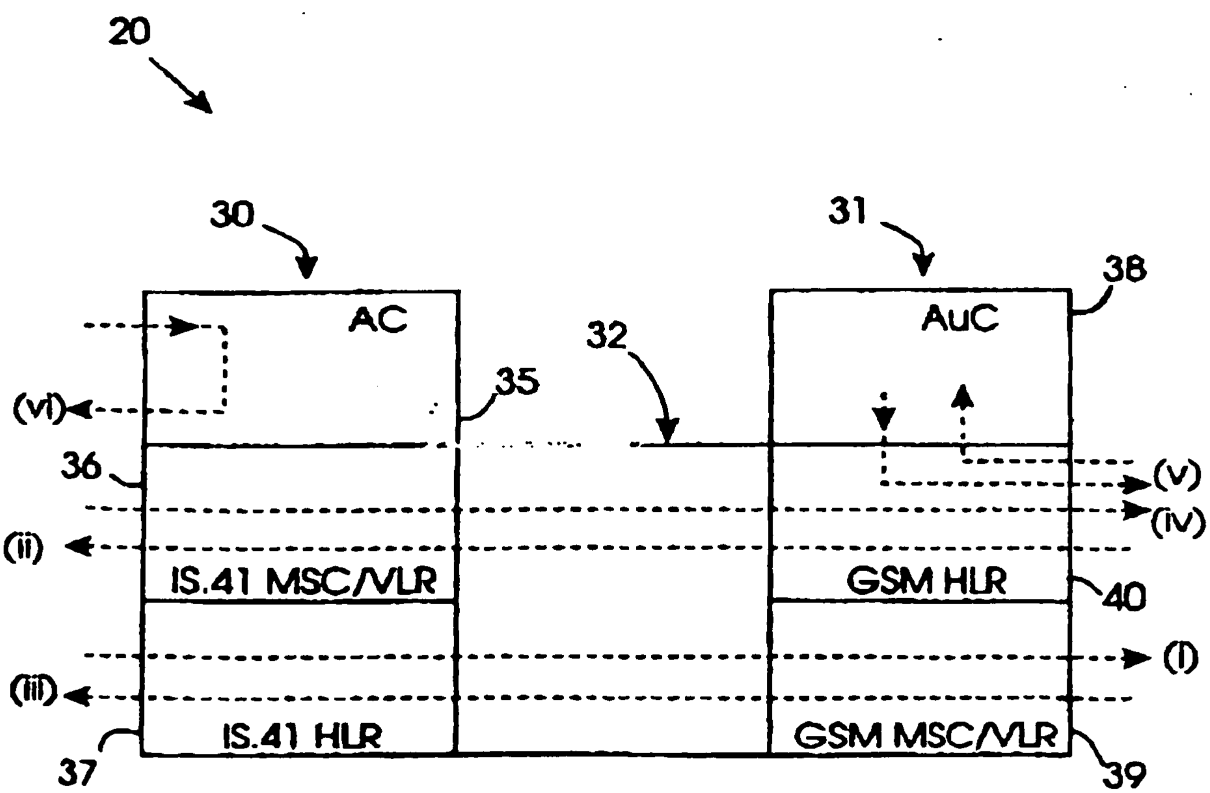

20
30
31
AC
AuC
38
32
35
(vi)
36
(v)
(iv)
(ii)
IS.41 MSC/VLR
GSM HLR
40
(i)
(iii)
IS.41 HLR
GSM MSC/VLR
37
39

Fig. 4

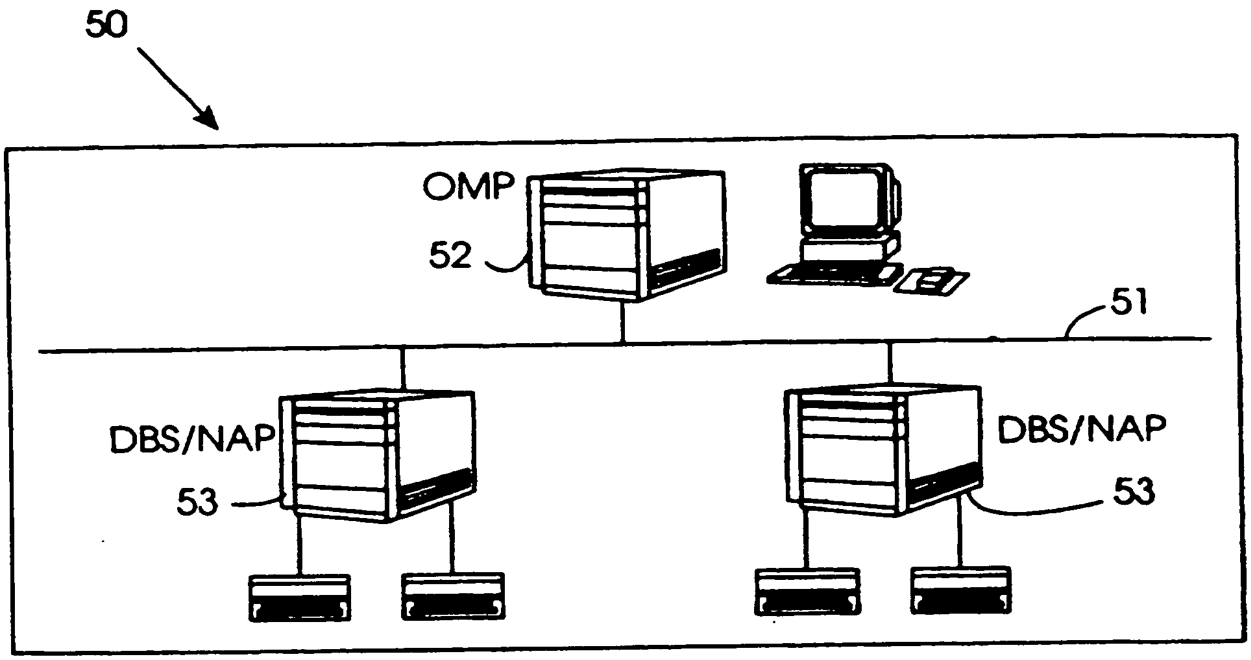

50
OMP
52
51
DBS/NAP
53
DBS/NAP
53

Fig. 5(a)

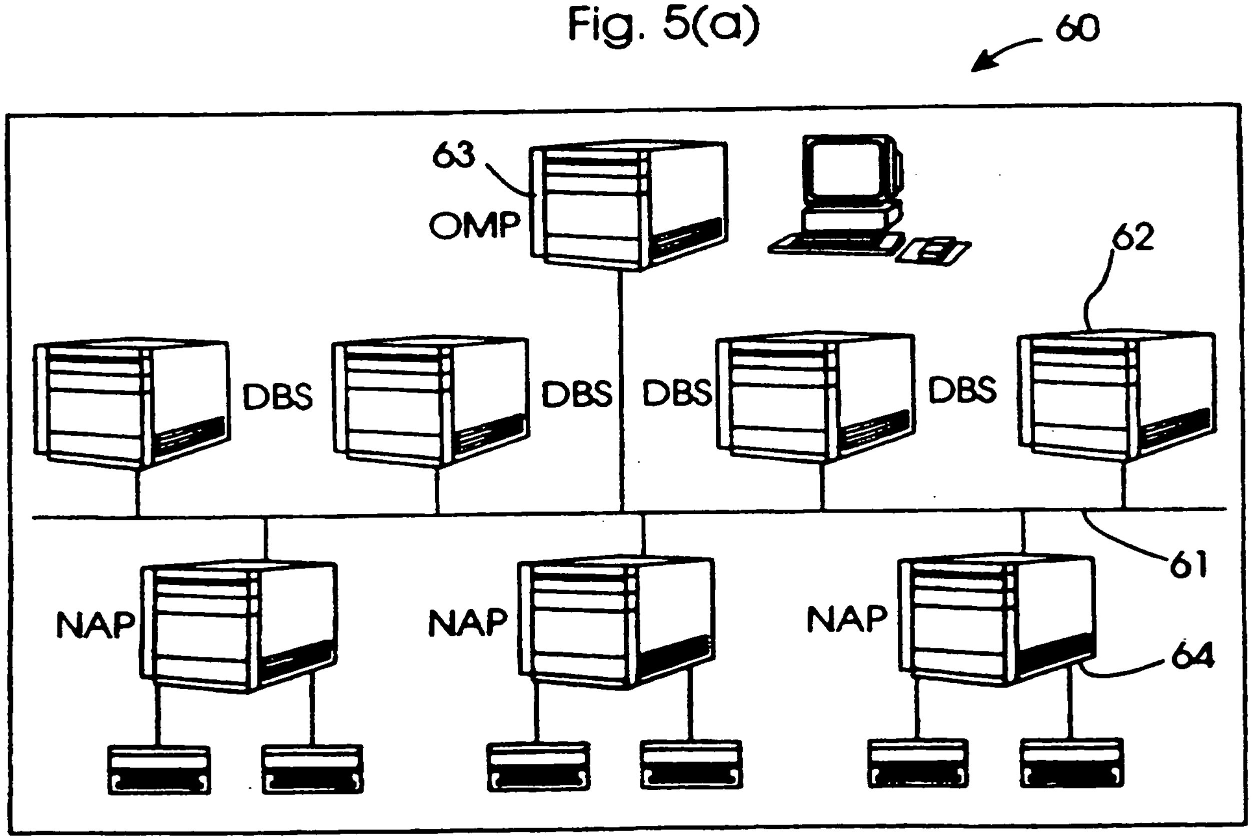

60
63
OMP
62
DBS
DBS
DBS
DBS
61
NAP
NAP
NAP
64

Fig. 5(b)

THIS PAGE BLANK (USPTO)

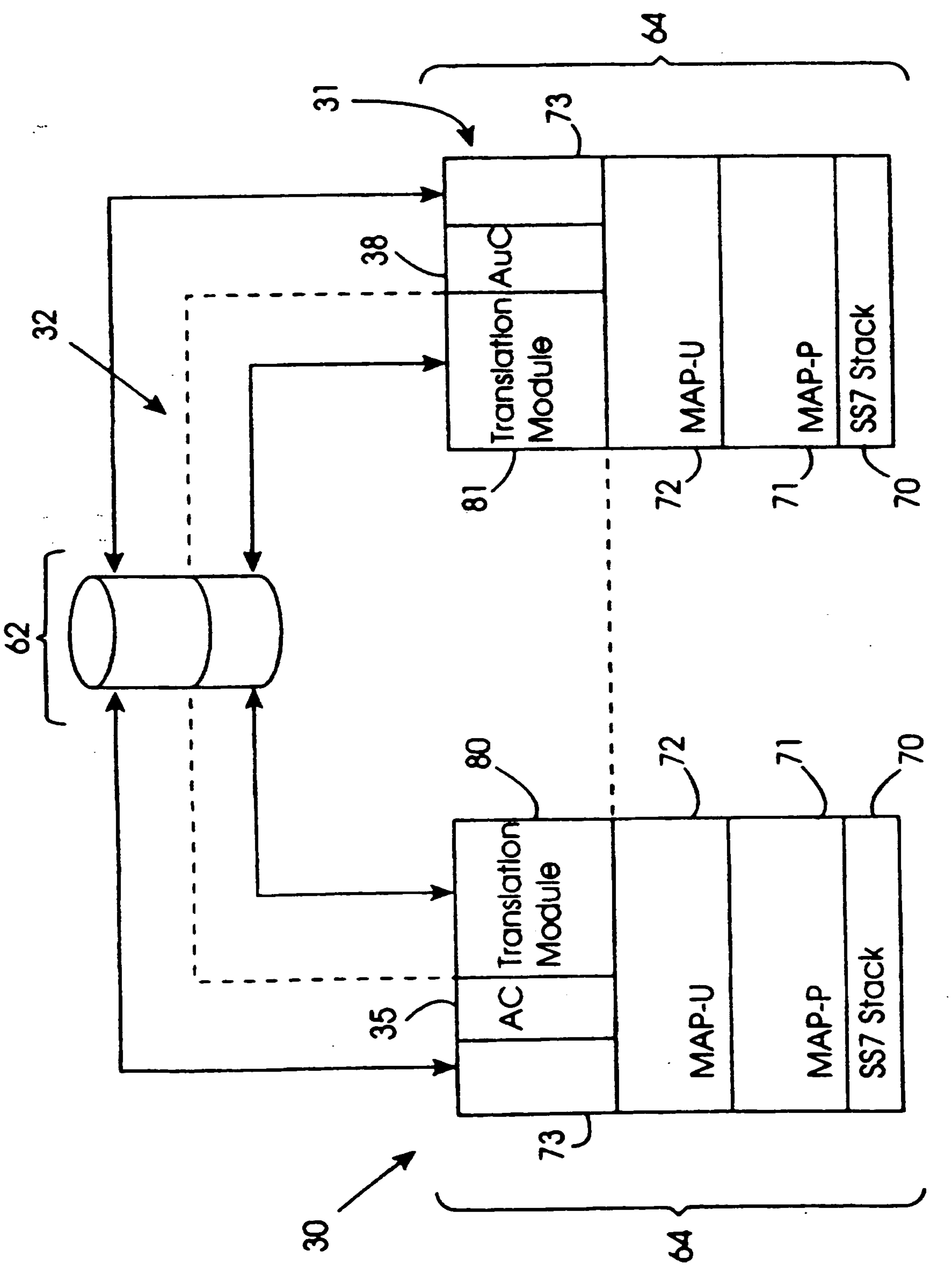

64
31
73
AuC
38
32
Translation Module
MAP-U
MAP-P
SS7 Stack
81
72
71
70
62
80
Translation Module
AC
35
MAP-U
MAP-P
SS7 Stack
73
30
64

Fig. 5(C)

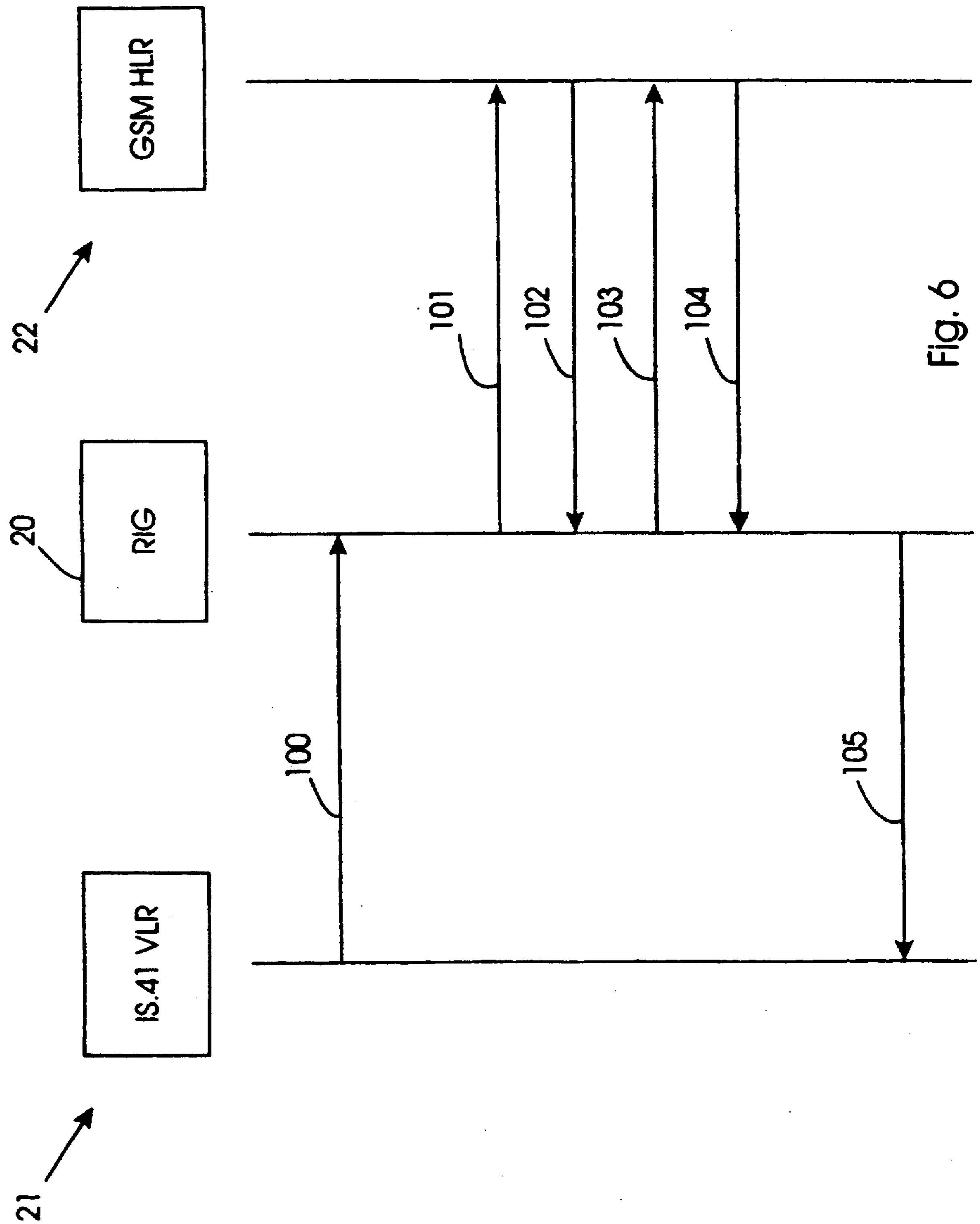


Fig. 6

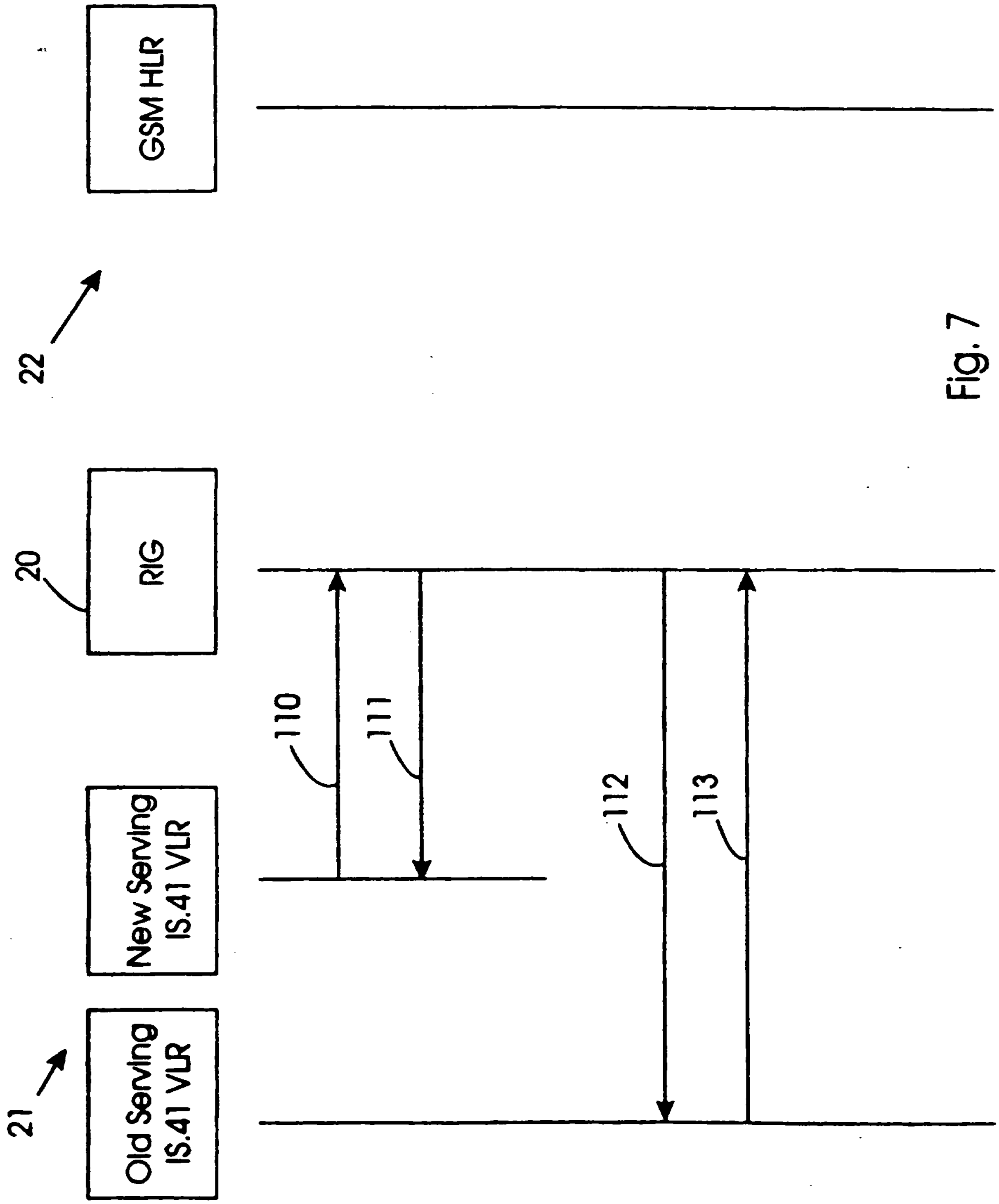

GSM HLR
22
RIG
20
New Serving
IS.41 VLR
Old Serving
IS.41 VLR
21
110
111
112
113

Fig. 7

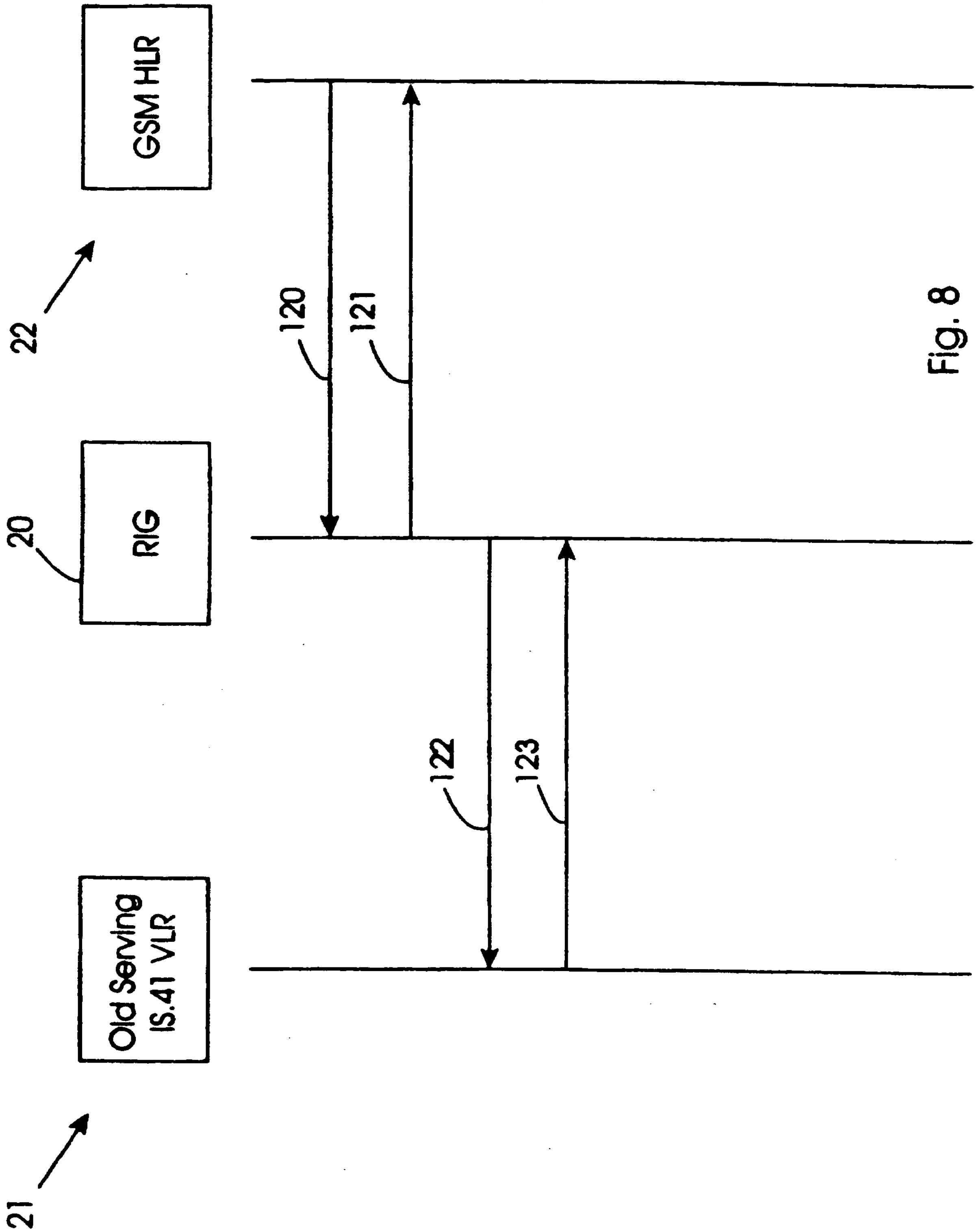


Fig. 8

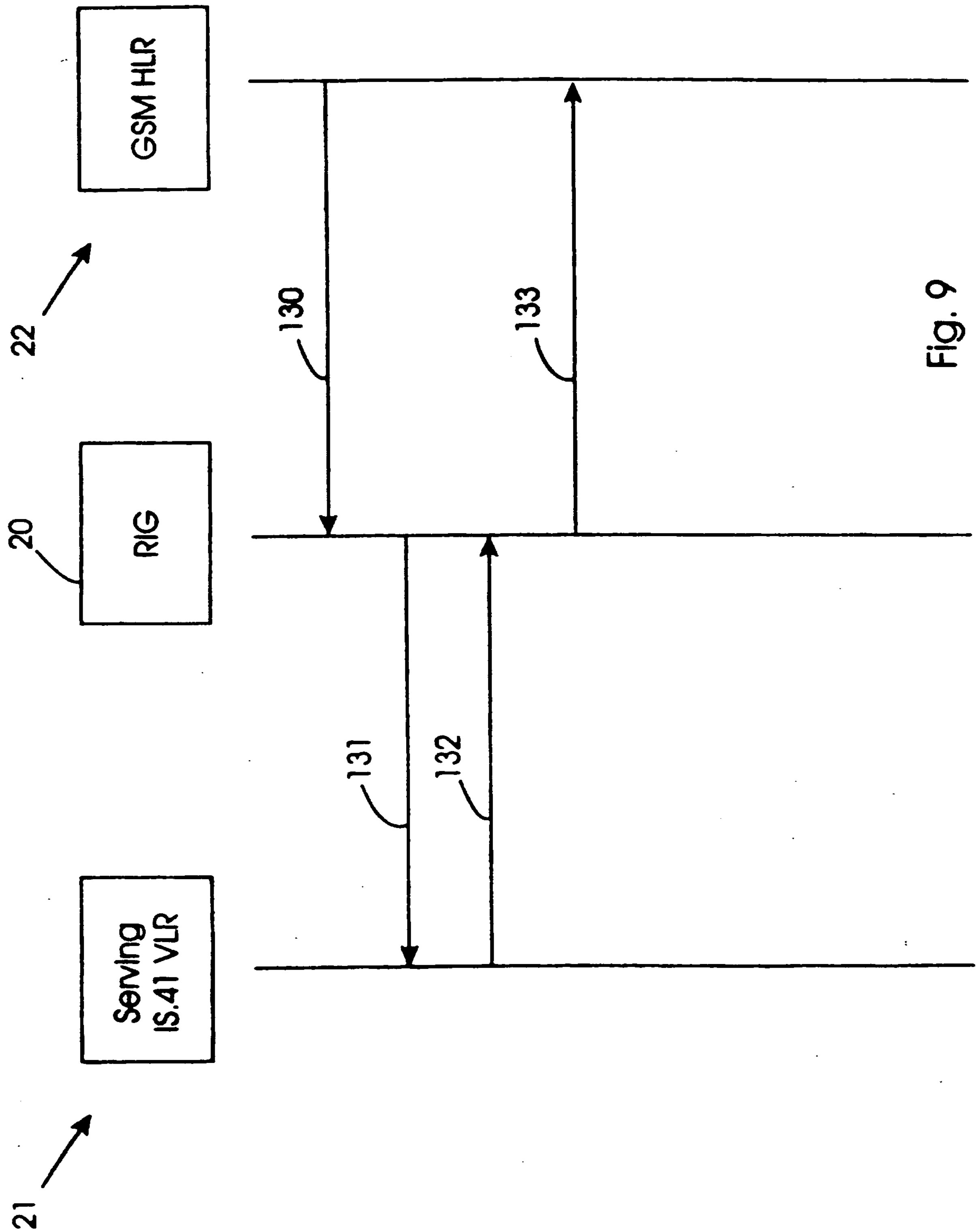


Fig. 9

INTERNATIONAL SEARCH REPORT

International Application No
PCT/IE 97/00027

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 H04Q7/38

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 H04Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	UCHIYAMA Y ET AL: "Network Functions and Signalling for Personal Roaming between Digital Cellular Standards" FOURTH IEEE INTERNATIONAL CONFERENCE ON UNIVERSAL PERSONAL COMMUNICATIONS. RECORD. GATEWAY TO THE 21ST CENTURY (CAT. NO.95TH8128), PROCEEDINGS OF ICUPC `95 - 4TH IEEE INTERNATIONAL CONFERENCE ON UNIVERSAL PERSONAL COMMUNICATIONS, TOKYO, JAPAN, 6 - 10 November 1995, ISBN 0-7803-2955-4, pages 447-451, XP002019703 see page 448, left-hand column, line 16 - page 451, right-hand column, line 20 ---	1-4,6-8

-/--

[X] Further documents are listed in the continuation of box C.

[ ] Patent family members are listed in annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

1

Date of the actual completion of the international search	Date of mailing of the international search report
25 August 1997	08.09.97

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Behringer, L.V.

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	NODERA Y ET AL: "Interworking between GSM and PDC through IC cards" ICC `95 SEATTLE. COMMUNICATIONS - GATEWAY TO GLOBALIZATION. 1995 IEEE INTERNATIONAL CONFERENCE ON COMMUNICATIONS (CAT. NO.95CH35749), PROCEEDINGS IEEE INTERNATIONAL CONFERENCE ON COMMUNICATIONS ICC `95, SEATTLE, WA, USA, 18-22 JUNE 1995, ISBN 0-7803-2486-2, pages 761-765 vol.2, XP000533114 see the whole document -----	1-3,5,13

1